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2. Preface

As in every field, technology moves fast in the area of electro-medical equipment.
Both electronically and medically, immense progress has been made over the last couple of years.

It goes without saying that comprehensive technical knowledge of the product is needed more than ever.
This manual aims to meet this ever increasing need by giving you a complete and accurate picture of the pulson 330, an advanced micro-computer controlled ultrasound apparatus.
In doing so, it will hopefully help you to reach your goal: to form a correct diagnosis and to solve the client’s problem as thoroughly as possible.

If you have any questions or if you need additional information about this manual or about the use of the pulson 330, please do not hesitate to contact us.

3. Introduction

The Pulson 330 is a modern micro-controlled apparatus, intended for ultrasound therapy.
It is a member of the Gymna family, and thus built according to the newest requirements concerning the European security standards.

The unit is portable and can therefore be used for in-house treatments as well as for domestic use.

The unit provides following possibilities: continuous and pulsed ultrasound at frequencies of 1 Mhz or 3 Mhz.

Combination therapy is possible and useful with following Gymna apparatus:

- Interdia 200
- Interdia NST
- Duo 400
- Duo 410

Two different or equal treatment heads can be connected at the same time, with the possibility to switch between.
Following heads are available:

- 1 Mhz head 5 cm^2
- 3 Mhz head 0.8 cm^2

The heads are insulated against parasitic side radiation and waterproof, which makes them suitable for underwater treatments.
Thanks to a built in efficiency resistor, the heads are fully interchangeable, without the need of recalibration of the output stage.
The treatment heads are also interchangeable with the Combi 410 unit .

4. Important remarks

4.1 Safety aspects

To understand and practice all procedures described in this manual a good technical background is a must.
Gymna will not be held responsible for any actions executed on the unit by unauthorized persons, or for executing any procedures not prescribed in this manual.

All information in this manual has a Gymna copyright.

4.2 Data registration.

The distributor must be able to provide the following data for each unit:

- Instrument data: Part and serial number.
  Gymna has the original configuration of each unit.
  The Pulson 330 has following critical parts:

  - Main board: part number: 10555
  - Display board: part number: 10578
  - Output stage board: part number:10558
  - Main power transformer: part number:9677
  - Inlet filter: part number:8552

  These parts have a serial number which has to be filed in case of a configuration
  change.

- Customer data: Name, full address and date of delivery.

  - Service activities: All service activities must be filed.
  - If any critical parts are changed, we also expect the distributor to file
  - the new serial numbers of these part(s).

To file this data, a data registration document is available on next page.

Data registration document

Information

Distributor name	Distributor address

Customer name	Customer address

Instrument name: Pulson 330	Serial number:
Date of delivery:	

Service activities

Date:		
Error complaint:		
Service action		
Critical spare parts exchange list		
Critical part name	**Old serial number**	**New serial number**
PCB Display.		
PCB Main.		
PCB.Ultrasound		
Power transformer.		
Ac inlet.		

Date:		
Error complaint:		
Service action		
Critical spare parts exchange list		
Critical part name	**Old serial number**	**New serial number**
PCB Display.		
PCB Main.		
PCB.Ultrasound		
Power transformer.		
Ac inlet.		

5. General technical data.

- Treatment unit

Mains voltage:	115/230 Vac +- 10%
Frequency:	50/60 Hz
Mains fuses:	1A type L
Current consumption:	maximum 500 mA
Dimensions	413 X 280 X 100 mm
Weight:	5 kg.
Labels	Hazard warning label Serial number label Type identification label Fuse value label Bauartzulassungs Nr. Manufacturer, mains, Voltage Frequency and power consumption

Class according to IEC601-1: I
Type according to IEC601-1: BF
Limits test values according to IEC 601-1:

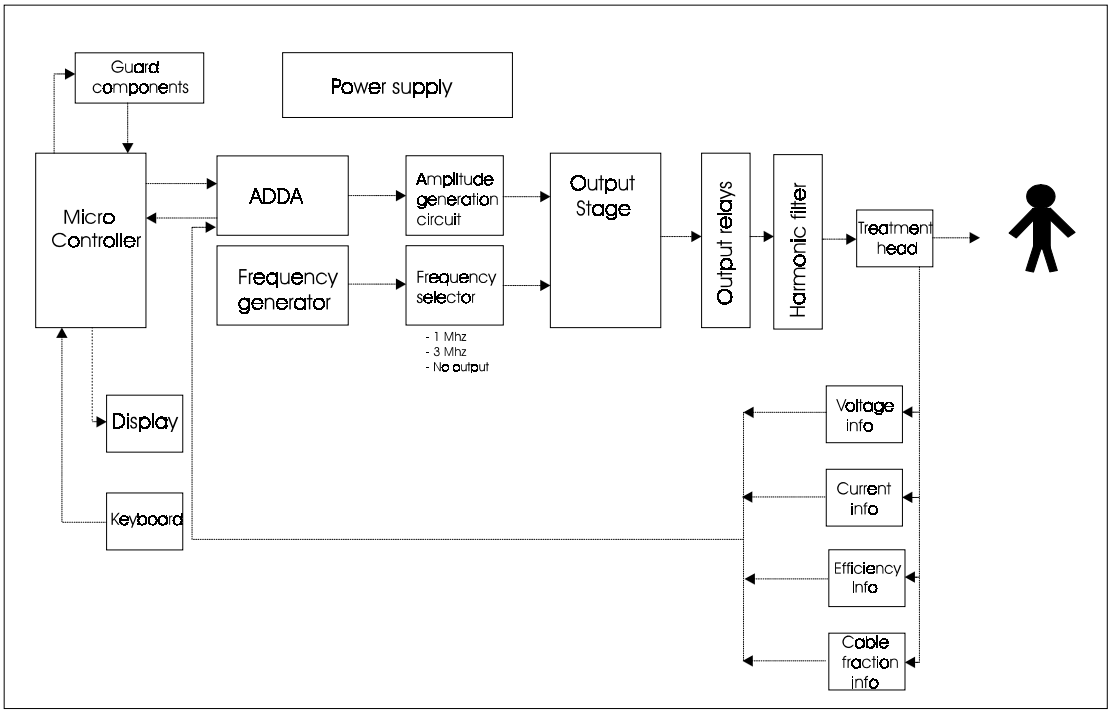
- Earth leakage current: IEC requirement < 500 μA
- Earth leakage single fault: IEC requirement < 1 mA
- Enclosure leakage current normal: IEC requirement < 100 μA
- Enclosure leakage single fault: IEC requirement < 500 μA
- Patient leakage normal: IEC requirement < 100 UA
- Patient leakage single fault: IEC requirement < 500 μA
- Patient leakage mains on applied part sfc: IEC requirement < 5 mA
- Patient auxiliary current normal: IEC requirement < 10 μA
- Patient auxiliary single fault: IEC requirement < 50 μA
- Earth resistance: typical 0.12 Ω

Number of channels:	2
Continuous use:	Yes
Useable in explosive environment:	No

- Treatment heads

1 Mhz, large:	Surface: 5 cm^2 Max output power: 10 W
3 Mhz, small:	Surface: 0.8 cm^2 Max output power: 1.6 W

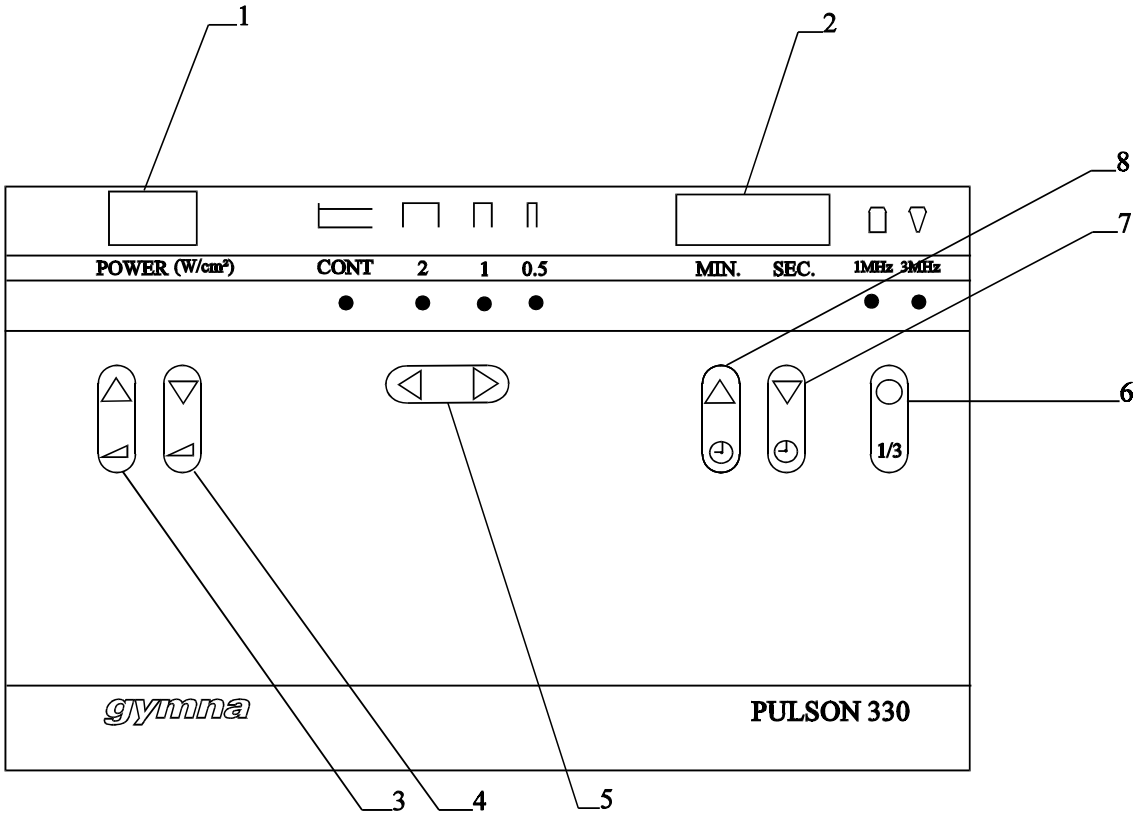
6. Block diagram.



- Reference list:

Microcontroller circuits: page 13
Guard components: page 13
Display: page 27
Keyboard: page 16
ADDA-convertor: page 19
Amplitude generation circuit: page 18
Frequency generation: page 20
Output stage: page 22
Output relays: page 23
Harmonic filter: page 22
Treatment heads: page 37
Voltage info: page 23
Current info: page 23
Efficiency factor info: page 18
Cable fraction info: page 24

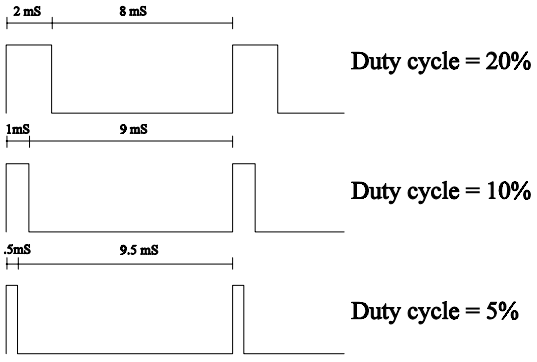
7. Operation panel



1. US- power display. The intensity is displayed in W/cm².
2. Treatment time display.
   Displayed in Min & Sec. Maximum treatment time is 30 minutes.
   The timer runs only when the contact control is sufficient.
3. Intensity up key. Maximum intensity is 2 W/cm•.
4. Intensity down key. Minimum intensity is 0.1 W/cm•
5. Output mode switch.
   There are 4 output modes

   - 1 continuous
   - 3 pulsed

   The modulation frequency is fixed at 100 Hz for all pulsed US-outputs.
   There is only a difference in duty cycle.



6. 1/3 MHz head selection key.

Is a key to switch from the 1MHz to the 3MHz head and back.
For a good understanding, some important notes have to be taken into consideration:

The right side panel has 2 US-output connections, CON2 and CON3.
The pulson 330 is designed in such a way that it always detects which head is
connected to which output gate.
In other words, both heads can be connected to both outputs, and it is of no
importance whether one ore two heads are connected.

The following examples may illustrate this:

- If both heads are connected and you switch on the instrument, it will always
  select the 1MHz head. If only the 3MHz head is connected, there is no other choice,
  so this one will be selected.

- If you want to switch from 1MHz to 3MHz, there are two possibilities:

  - The 3MHz is connected.
    Press the 1/3 MHz and the switch is made.

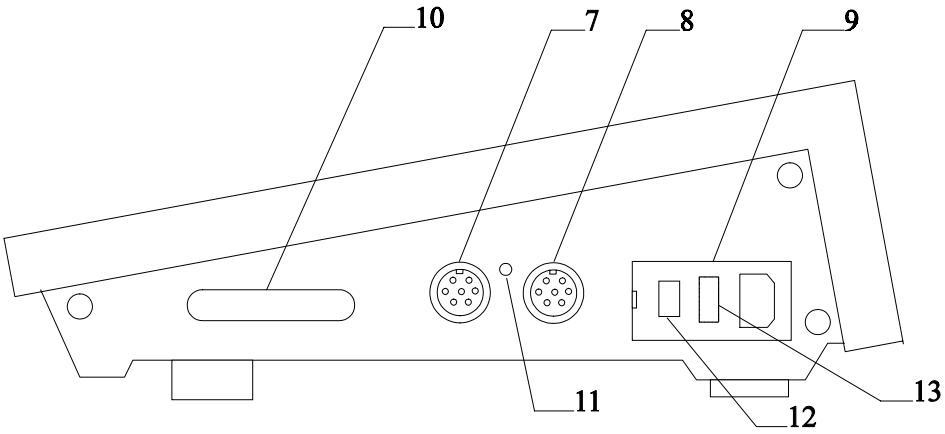
  - The 3MHz is not connected.
    The instrument doesnít find the other head. The 3MHz led flashes for 10 sec.
    after which the 1MHz is selected again.

- If only the 1 MHz is connected, and you pull out this head, both leds start flashing
  for about 10 sec., after which they extinguish.

- If two heads are connected and you pull ot the 1MHz while using it for a treatment,
  the instrument will immediately switch off the US-power and select the 3MHz head.

7. Timer down switch.
8. Timer up switch.
The treatment time can be changed in steps of a min. if time > 1 min. If the treatment
time < 1 min. the timer can be changed in steps of a sec.

8. Right side panel.



7. Output connector 1 (CON 1). Can be connected to a 1/3 Mhz. head.
8. Output connector 2 (CON 2). Can be connected to a 3/1 Mhz head.
9. Mains entrance.
   The pulson 330 must be connected to a wall socket with a earth contact.
   Use only the original cable that is supplied with the apparatus in the
   accessories package.
   Check whether the required supply voltage, mentioned on the serial number plate,
   corresponds with the available mains supply ratings.
10. Serial number plate.
   On this plate the serial number, as well as the required supply voltage and
   frequency are mentioned.
   Also the mains fuses ratings are mentioned.
11. Plug for combination therapy.
   Via this plug, the pulson 330 can be linked with another GYMNA apparatus
   in order to perform combination therapy.
12. Power switch.
   Will light up when the power is switched on.
13. Mains fuses. 2 Fuses of 1 A type L.

9. Power supply.

Main fuses are inserted in the main entrance (F1 and F2, 1A fast).
The transformer contains a thermic fuse . It will cut off the primary winding, when the inside temperature exceeds 120 °C. To switch on again, transformer temperature has to go below about 60 °C.
For this reason, there is no need for secondary fuses anymore.
The ringcore transformer can be fed either with an incoming voltage of 230V/50Hz (CON 6) or with 115V/60Hz (CON 5).
There are 2 secondary windings. Output voltage of winding 1 is 22V, winding 2 produces 8V.

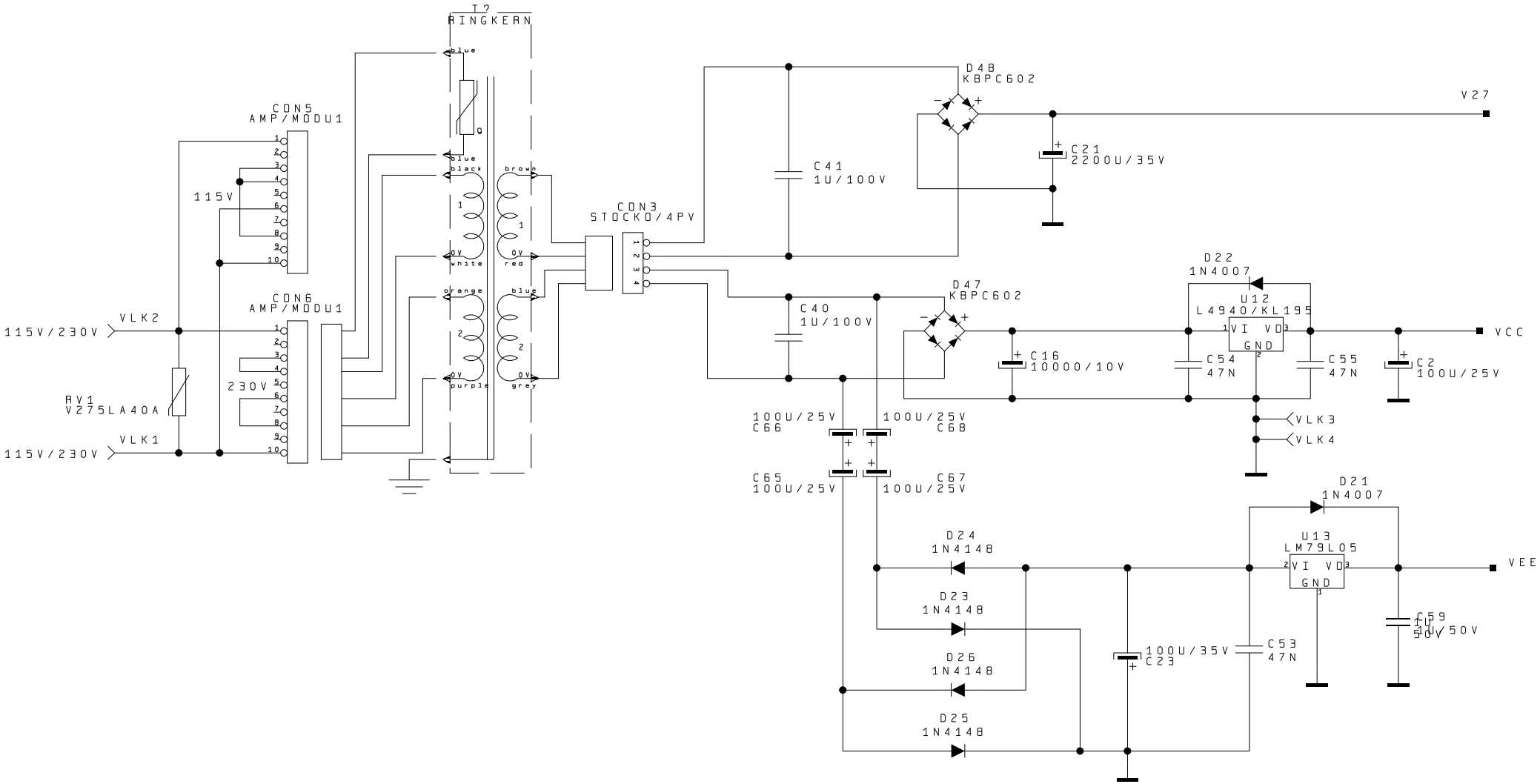
Power supply output voltages:

1. VCC: Is a 5V stabilised voltage, with a maximum output current of 700 mA.
   D22 protects U12 during switch off.

2. VEE: Is a -5V stabilised voltage, with a maximum output current of 100 mA.
   D21 protects U13 during switch off.

3. V27: Is a non stabilised power supply of approximately 27V.

VLK3: analog ground, connected to the metal cover-shield of pcb 2.
VLK4: analog ground, not connected and can be used for service.
RV1: Varistor. Filters out spikes on the incoming voltage.



components marked with * are optional

gymna repro NV		
TITLE	RESET & POWER SUPPLY	
DOCUMENT NUMBER	ELUL004-E101	Rev. 2.1
DATE-1: 22/05/95 DATE-2: 24/08/95 DATE-2.1: 11/07/01	DESIGN: E. Vanspauwen DRAWING: J. Vlemmix	Sheet 1/4
LAST SAVE: 11-8-1995_15:24		Size A2

10. Microcontroller circuits.

10.1 The microprocessor (µp).

The pulson 330 uses a Z86E21, a One Time Programmable (OTP) microcontroller which controls all sequences necessary for the apparatus to function.
It has on board ROM (8K), and RAM. Clock speed is defined by an external crystal, which runs at 12 MHz.

10.2 Microprocessor guard components.

To monitor the proper functioning of the µp, some external components are added.

1. U2 (MAX1232): µp supervisor IC.
   Does constant monitoring of VCC. When it goes below 4.75 V, a pulse with a fixed length is produced, to assure a good reset of the µp.
   R7 is a pull-up resistance and C3 filters out burst signals which may possibly disturb the µp.
   U2 also monitors the watchdog output of the µp. In case of processor hang-up,
   the same reset pulse is given.

2. U6 (74HC4538): output circuit protection IC.
   In case of processor hang-up, the output stage has to be switched off
   immediately.
   When the output VUS_EN goes low/high, Q10 switches and AMP_US goes to
   zero. This IC is also controlled by the watchdog output of the µp.

10.3 I≤C bus

The combination of outputs SCK and SCD forms a serial bus which follows the I•C protocol.
A maximum of 10 components, each having their own address, can be connected.

In this case 3 components are connected.

1. U10 (24C16)
   This is a 2K eeprom, which can be written during the special service routine.
   It contains the calibration data of the output stage and a copy of the checksum from the µp ROM. Each time the instrument is switched on, the µp calculates
   the ROM checksum and compares it to the value in the eeprom. In case of difference an error code will be displayed. Refer to error codes:

2. U15 (PCF8591)
   ADDA IC. Data coming from and going to this IC are sent by the I•C bus.
   For more information refer to US power circuits, page

3. Display.
   Connection to the display pcb is made by CON7.
   All display data arrive via this bus.

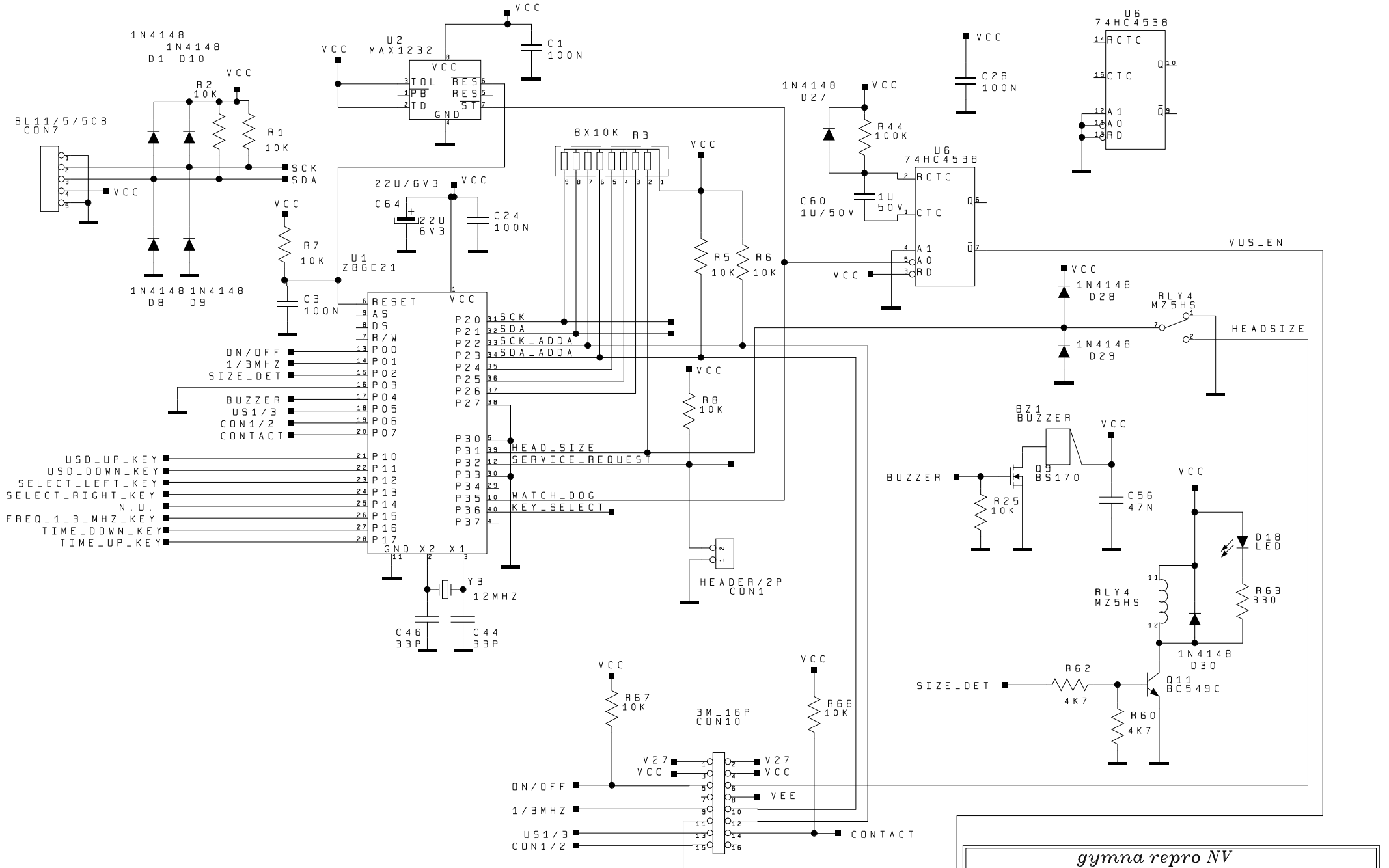
10.4 Relay 4 (RLY4).

After the instrument has been switched on , or the 1/3 MHz-key has been pressed, the μp checks the head sizes of all heads connected. RLY4 closes the HEAD_SIZE line, and reads the size of all heads connected to the apparatus.
After reading, RLY4 opens again. This is done in order to obtain a galvanic separation of
the outputs in case of combination therapy.

10.5 Microprocessor (μp) pin description.

- USD_UP_KEY Input signal. Switches to logic low level when the ultrasonic density up key is pressed.
- USD_DOWN_KEY Input signal. Switches to logic low level when the ultrasonic density down key is pressed.
- SELECT_LEFT_KEY Input signal. Switches to logic low level when the left output mode key is pressed.
- SELECT_RIGHT_KEY Input signal. Switches to logic low level when the right output mode key is pressed.
- N.U. Not used.
- FREQ_ 1_3_MHZ_KEY Input signal. Switches to logic low level when the 1/3 MHz. key is pressed.
- TIME_DOWN_KEY Input signal. Switches to logic low level when the time down key is pressed.
- TIME_UP_KEY Input signal. Switches to logic low level when the time μp key is pressed.
- WATCH_DOG Output signal. In case of μp hang up, this signal is at logic high level.
- KEY_SELECT Output signal. Logic low enables hardware information to be read in the μp. Logic high level disables hardware information and connects the keyboard to the μp.
- VUS_EN US voltage enable. Low/high active. Disables output stage in case of μp hang up.
- SCK Serial clock. Clock signal for I•C- bus.
- SDA Serial data. Data signal for I•C- bus.
- SCK_ADDA Clock signal for I•C -bus, connected only to U15 (ADDA)
- SDA_ADDA Data signal for I•C-bus, connected only to U15(ADDA)
- HEAD_SIZE Input signal. This line is read during initialising, to let the μp know the head sizes of the heads connected.
- SERVICE_REQUEST High active. When a jumper is placed on CON1 , this line switches to logic high level and the service routine is activated.
- ON/OFF Output signal: When this signal is at logic high level, the 1/3 MHz signals are cut off, which results in 0 W output. This signal will switch on/off at 100 Hz in case of combination therapy.
- 1/3 MHZ Output signal. When this signal is at logic high level, the 3 MHz base frequency is selected.

- SIZE_DET — Output signal, high active. Activates RLY4 during start-up in order to detect head size of all heads connected to the instrument.
- US 1/3 — Output signal. In case of logic high level, RLY1 is activated. At this time, RLY 3 , which is always in opposite position, is inactivated.
- CON 1/2 — Output signal. High logic level selects output connector 2 (CON2).
- RESET — Low active. In case of µp hang-up, or VCC-failure, U2 creates a reset pulse.
- BUZZER — Buzzer sounds when the output is at logic high level.



components marked with * are optional

gymna repro NV		
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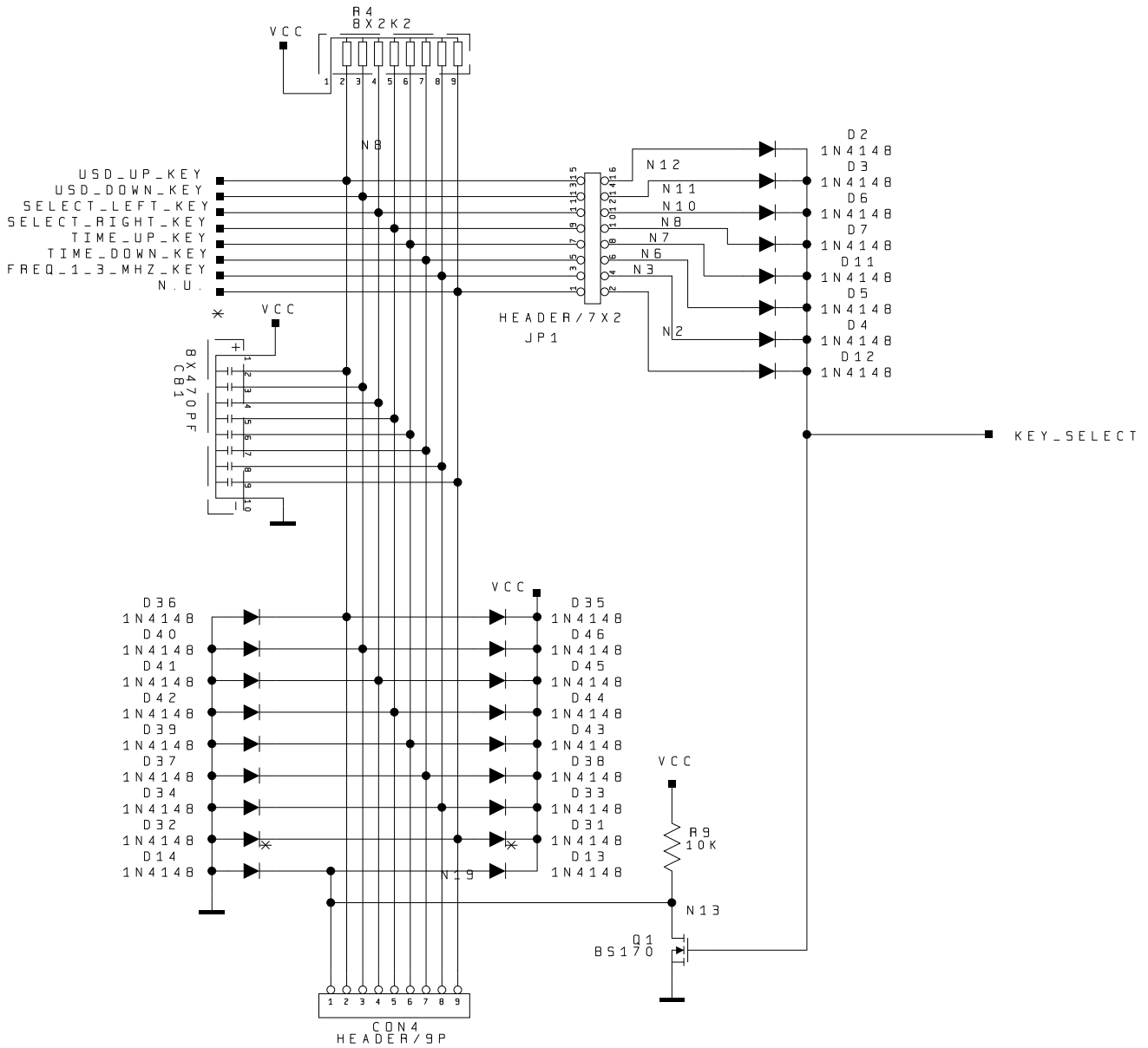
LAST SAVE: 7-11-2001_12:19		Size A2

11. Keyboard.

The keyboard consists of only 7 keys, which therefore can be directly coupled to the µp.
C8 filters out all HF-noise, and all diodes prevent keyboard discharges from entering the processor inputs.
The keyboard is connected to CON4.

Another feature of this circuit is the ability to detect the hardware version from the apparatus.
There are two possibilities: either the hardware version (defined by jumpers on JP1) or the keyboard information is read. The selection is made by the KEY_SELECT pin.
In case of a high level signal, Q1 opens and the µp reads the keyboard status. If KEY_SELECT is low, hardware version jumpers are read into the µp.
When starting up, the µp first reads the hardware version, and then checks if the present software version corresponds. If not, an error code is produced.
Hardware and software version may simply be checked by holding a key when starting up.
Both will be displayed for about 10 seconds, after which the unit returns to standby.



components marked with * are optional

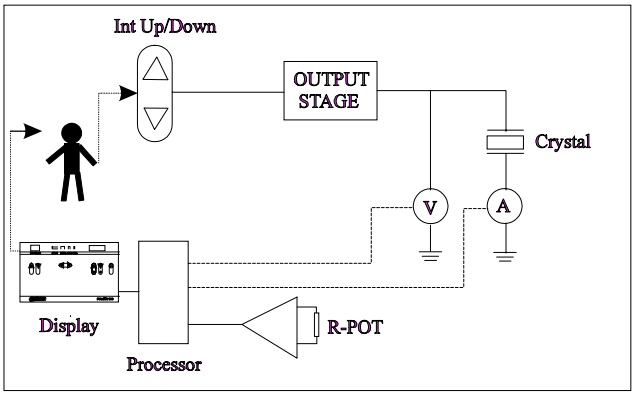
gymna repro NV		
TITLE	KEYBOARD	
DOCUMENT NUMBER	ELUL004-E106	Rev. 2.1
DATE-1: 22/05/95 DATE-2: 24/08/95 DATE-2.1: 11/07/01	DESIGN: E. Vanspauwen DRAWING: J. Vlemmix	Sheet 4/4
LAST SAVE: 7-11-2001_12:18		Size A2

12. US power and output stage.

12.1 Measuring and displaying US power

When the INT_UP key is pressed, a certain output voltage (1 or 3 MHz) is obtained, and the crystal starts vibrating on resonance frequency.

However, not all electrical power is transformed into acoustical vibrations. Since the crystal has a certain resistance during treatment, heat will be produced as well.
Consequently, different crystals may have different efficiency factors, which can be measured in a test lab. After measurement, each crystal gets a resistance, which represents this efficiency factor.
The microprocessor is able to read this resistance and to process this value, in order to display the right output power.
This means that with a low efficiency head, the pulson will display less output power than with a high efficiency head. This resistance is therefore soldered into the plug of the treatment head.



Pi is the input power, calculated by measuring US_VOLTAGE and US_CURRENT.
Pu is the output power in an ideal medium (0% reflections).

Pu = Pi * ηhead * ηoutput stage

The R_POT value represents the efficiency of the head (ηhead), and is constantly monitored by the μprocessor. It also makes it possible to see whether the head is connected or not.
The efficiency of the output stage (ηoutput stage) is determined during calibration and its value is saved in the eeprom.
Knowing these values enables the μp to calculate and display the output power.

Output power is determined in following way:

1. User presses INT_UP key
2. A certain output is obtained.
3. Current and Voltage information are sent to the μp.
4. The μp calculates the output power, thereby taking the efficiency values into consideration.
5. The user can see the output power displayed and can change it by pressing the INT_UP/DOWN keys.

In other words, some measurements are performed, the output power is displayed and the feedback is performed by the user himself (by pressing the intensity keys).
Notice that US_VOLTAGE and US_CURRENT are both peak values.
Measuring of these values is done just before the end of the US-pulse, or in case of the continuous ultrasound mode 32 times per second.

12.2 Automatic power density limitation.

The equipment automatically reduces the US output density to about 2W/cm•. When the calculated value exceeds 2.2W/cm•, the equipment tries to reduce the output power by reducing US_AMPLITUDE, the output voltage of the ADDA.

12.3 Switched mode power supply.

U1 (MC33166), and the circuits around it, define the switched mode power supply. By connecting this signal to the output transformer, the output power is regulated.
Input of U1 is V27, a non stabilised voltage of approximately 27 V.
U1 consists of a Fet and a comparator with a reference voltage of 5.05V.
When the feedback voltage goes below 5.05V, the output fet will switch on and open. When the feedback voltage exceeds 5.05V, the fet will cut off the incoming voltage.
Consequently, the addition point of R31//R36, R35+R38 and R34 will always be kept
at 5.05V.

Since the output of U3 varies between 0 and -3 V and the addition point is always 5.05 V, the voltage of TP8 can -according to the output of U3- vary between 0 and 25 V.
The 5V supply connected to R35 has an accuracy of 1%.
When the fet is conducting, L9 as well as C80 will load. At a certain point, the feedback voltage will surpass the reference and the fet will be cut off. At this point, L9 sees its incoming voltage go down, and wants to work against it. L9 becomes supply, D6 starts conducting and C80 can reload again. When all this energy is consumed by the output stage, the feedback voltage of the comparator will fall below the reference value of 5.05V and the fet will reopen the circuit.
Since the inside fet constantly switches you can see a rectangular waveform at the output of U1. When more power is needed, the frequency of this waveform will raise as well as the pulse time.
A great advantage of this switched supply is the high efficiency factor of about 90%.
The instrument consumes less power and the heat production will be much lower.

12.4 The ADDA convertor.

U15 (PCF8591) is an ADDA convertor, which has 4 multiplexed analog inputs and one analog output. For a good AD conversion, a very stable reference voltage is necessary. This reference is derived from V27.
D15 is a zener IC, which gives a 0.1% accurate 5V output.

List of the most important input/output signals:

- **US_VOLTAGE**: Input signal: Peak value of the measured output voltage
- **US_CURRENT**: Input signal: Peak value of the measured output current.
- **RPOT_CON1**: Input signal: This voltage represents the value of the efficiency resistance fixed in the plug of the head connected at CON1
- **RPOT_CON2**: Input signal: This voltage represents the value of the efficiency resistance fixed in the plug of the head connected at CON2.
- V ref: Input: this is a 0.1% accurate voltage of 5V derived from V27.
- **SCK_ADDA**: Is the incoming serial clock of the I•C bus.
- **SDA_ADDA**: Is the bidirectional I•C data bus.

The info of signals 1 to 4 are sent to the µp which will interprete these signals in order to determine output power, to detect the quality of contact and to see which ;heads are connected.
The only information coming from the µp is the wanted US_AMPLITUDE (see 8).

- **US_AMPLITUDE**: Voltage between 0 and -3V which will eventually determine the AMP_US voltage.
The only factors which influence this voltage are the intensity keys.

The US_AMPLITUDE is inverted by U3 and presented to the addition point of the switched power supply. Q10 is connected to VUS_EN. In case of processor hang-up Q10, immediately connects the input of U3 to ground, which results in a output power of 0W.

The 5V used as a reference for the ADDA is also the base voltage for an accurate 10V supply, which is used in the switched power supply. To assure proper working of the opamp (U3), the incoming voltage is divided in two. To get 10V out of 2.5V we need a dc-amplifier.
Q9 converts voltage into current and Q11 converts current into voltage.

12.5 Output frequency generation.

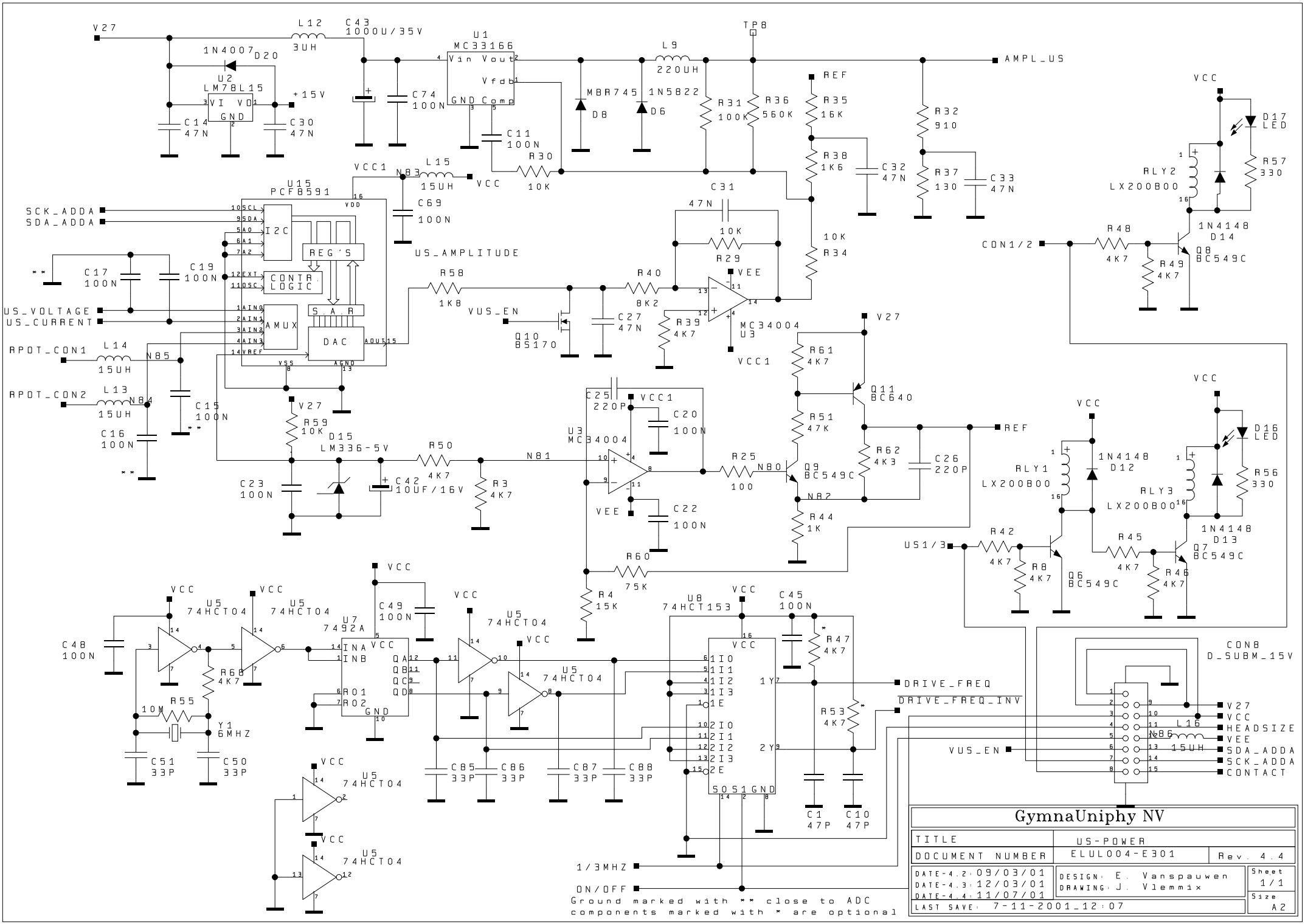
A quartz connected to U5 produces a 6MHz signal. U7 (7492A) is a divider with an 1MHz output on QA and a 3MHz output on QD. These two signals are inverted through U5 and fed to U8 (74HCT), a dual channel multiplexer (2*4 inputs), which will actually work as a switch. The non-inverted signals are fed to channel 2 and the inverted signals are fed to channel 1 of U8.
S0 (1/3 MHz) and S1 (ON/OFF) are the selection bits; if S0=S1=0 then inputs 1I0 and 2I0 are selected and presented as outputs. In other words, depending on the selection bits an input is selected. This results in two outputs: DRIVE_FREQ and NOT DRIVE_FREQ, the two signals we need to amplify at the output stage. See table on next page for other possible combinations.

S0	S1	DRIVE_FREQ	NOT DRIVE_FREQ
0	0	1MHz	not 1MHz
1	0	3 MHz	not 3MHz
0	1	VCC	VCC
1	1	VCC	VCC

12.6 Relay drivers

Q6: is the driver of relay 1
Q7: is the driver of relay 3, which is always the opposite of relay 1.
D16 lights when this relay is activated.
Q8: is the driver of relay 2.
D17 lights when this relay is activated.

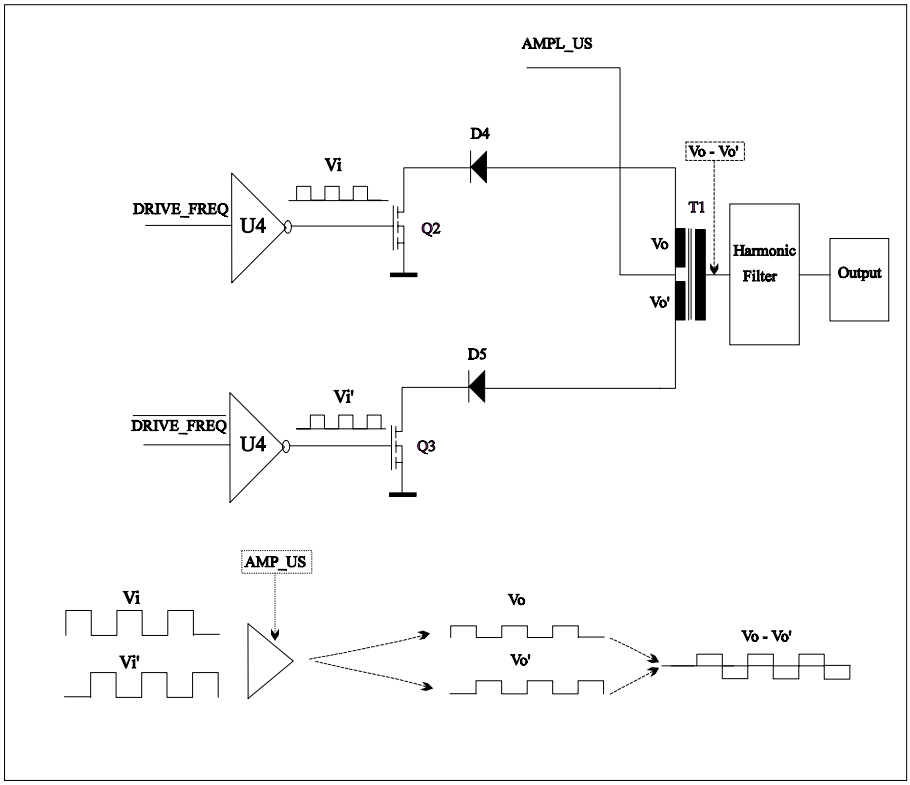
See 5.7 for further information on the use of these relay.


V27
L12
3UH
C43
1000U/35V
1N4007
D20
U2
LM78L15
+15V
C14
47N
C30
47N
U1
MC33166
Vin
Vout
Vfdb
GND
Comp
C74
100N
C11
100N
MBR745
D8
L9
220UH
1N5822
D6
TP8
R31
100K
R36
560K
AMPL_US
REF
R35
16K
R38
1K6
C32
47N
R32
910
R37
130
C33
47N
VCC
D17
LED
RLY2
LX200800
R57
330
1N4148
D14
Q8
BC549C
R48
4K7
R49
4K7
CON1/2
VCC1
N83
L15
15UH
VCC
C69
100N
R30
10K
U15
PCF8591
VDD
SCK_ADDA
SDA_ADDA
I2C
REG'S
CONTR.
LOGIC
S.A.R
AMUX
DAC
AOUT
AGND
VSS
VREF
C17
100N
C19
100N
US_VOLTAGE
US_CURRENT
US_AMPLITUDE
C31
47N
10K
R29
10K
R34
R58
1K8
R40
8K2
VUS_EN
Q10
BS170
C27
47N
R39
4K7
VEE
MC34004
U3
VCC1
V27
R61
4K7
Q11
BC640
RPOT_CON1
L14
15UH
N85
RPOT_CON2
L13
15UH
N84
C15
100N
C16
100N
R59
10K
D15
LM336-5V
R50
4K7
N81
C23
100N
C42
10UF/16V
R3
4K7
C25
220P
C20
100N
R25
100
N80
Q9
BC549C
R51
47K
R62
4K3
C26
220P
N82
R44
1K
C22
100N
R60
75K
R4
15K
VCC
D16
LED
RLY1
LX200800
1N4148
D12
RLY3
LX200800
R56
330
1N4148
D13
US1/3
R42
4K7
R8
4K7
Q6
BC549C
R45
4K7
R46
4K7
Q7
BC549C
U5
74HCT04
U7
7492A
U8
74HCT153
C48
100N
C49
100N
C45
100N
R68
4K7
R55
10M
Y1
6MHZ
C51
33P
C50
33P
C85
33P
C86
33P
C87
33P
C88
33P
R47
4K7
R53
4K7
C1
47P
C10
47P
DRIVE_FREQ
DRIVE_FREQ_INV
1/3MHZ
ON/OFF
CON8
D_SUBM_15V
L16
N86
15UH
V27
VCC
HEADSIZE
VEE
SDA_ADDA
SCK_ADDA
CONTACT
VUS_EN
Ground marked with ** close to ADC
components marked with * are optional
GymnaUniphy NV
TITLE
US-POWER
DOCUMENT NUMBER
ELUL004-E301
Rev. 4.4
DATE-4.2: 09/03/01
DATE-4.3: 12/03/01
DATE-4.4: 11/07/01
DESIGN: E. Vanspauwen
DRAWING: J. Vlemmix
Sheet 1/1
LAST SAVE: 7-11-2001_12:07
Size A2

13. US output stage

Normally, DRIVE_FREQ is a 1or 3MHz signal. However, when the output stage is switched off, it will be equal to VCC.

Working: The 1/3 MHz square wave signals (DRIVE_FREQ and NOT DRIVE_FREQ) are fed to the two buffers of U4, which are necessary because on these frequencies, the gates of fets Q2 and Q3 are able to consume about 300 mA.
Because Q2 and Q3 alternately switch on/off, the supply current (AMPL_US) is
alternately routed from the center tab of T1 via D4 to Q2, or via D5 to Q3.



With the output transformer T1, these signals are mixed and induced in the secondary
winding.
The cut off level of D4 and D5 can be influenced by changing the AMP_US voltage, and
thus the output power is changed as well.
However, the output signal of T1 is still a rectangular waveform. The addition of an
harmonic filter results in a sinusoidal waveform of 1 or 3 MHz.

The combination L10, L2, C77 and C78 is the harmonic filter for 1MHz.

The combination of L1, C84, R1, R2 and C79 is the harmonic filter for 3MHz.

The combination of L8, C2, C21 and C3, make the circuit resonant for 1MHz.
L6, L7 and C76 act the same but for 3MHz. Depending on the selected treatment head,
RLY1 selects the right resonance filter and the right harmonic filter at the same time.

13.1 Output voltage and current measurement.

In order to display the output power and to monitor whether there is sufficient contact between the head and the treatment surface, an voltage and current measurement are necessary.
For all measurements, only peak values are used.

13.1.1 Voltage measurement.

The voltage measurement circuit is directly derived from the output.

For 1MHz: the incoming voltage is divided by 10 which is the ratio of R14 to
R12//R13. With D1 this circuit becomes an AM detector.
For 3MHz: the incoming voltage is divided by 2 which is the ratio of R15 to R16.
With D2 this circuit becomes an AM detector.

Since only 1 frequency can be selected, either D1 or D2 will be cut off.
So, depending on which frequency is selected, on of these signals is presented to the peak detector, made by R11 and C35.
Followed by U3 (MC3400), this circuit is an AM demodulator, which results in a DC value (US_VOLTAGE), corresponding to the peak value of the output voltage.

13.1.2 Current measurement.

R41 is a measuring resistance of 0.1 Ω. The maximum output current is 2.5A which results in a maximum voltage over R41 of 0.25V. Since this value is much to low to present directly to the peak detector, we need to amplify it.
In the amplifier circuit, composed round Q1 and Q5, the gain is 5x.
This signal is single rectified and presented to the peak detector, made by C36, R17 and D17.
Together with opamp U3, it works as an AM demodulator, which results in a DC voltage,
(US_CURRENT), corresponding to the peak value of the output current.

13.2 Relay circuits.

Some relays are necessary in order switch between the output connectors and to switch through the right frequency. Each relay has its own led which will light up when the relay is activated.

- RLY1: Switches from 1 to 3MHz and back, in the output stage. The resonance filter and the harmonic filter are selected at the same time (see 5.7).
  If the relay is not activated, 1 MHz is selected and the corresponding led is extinguished.

- RLY2: This is the output connector switch.
  Not activated means that CON1 is selected as output. When the relay is activated; CON2 is selected.
  RLY2 switches trough the output signals as well as the current information.

- RLY3: Selects one of the outputs of the 1or 3MHz harmonic filter, plus it makes it possible to detect the headsize of all the heads connected to the outputs.

When the instrument is switched on, the relays is not activated. At this time the μp has the possibility to detect the head size of the head connected to CON2.
After a second, the relays will be activated and head size detection of CON1 is performed.

However, only the 3MHz head has a head detection bridge inside the plug. This means that the μp at this point is unable to see if either there is a 1MHz head connected, or there is no head connected. Therefore the RPOT lines are used.
Since all heads do have a resistance fixed in the plug, the μp can always see whether a head is connected or not.

In other words, by checking the head sizes of both outputs (by means of RLY3), and by taking the RPOT values into consideration, the μp knows which heads are connected to which outputs.

After detection, the relays will choose the 1 or 3MHz output of the harmonic filters. At this point, the position of the relay at the head size detection is of no importance.
The relay, and its led, will be activated in case of the 1MHz selection.

13.3 Contact control

order to detect the quality of contact between the ultrasound head surface and the treated tissue, the equipment processes the measured voltage and the measured current through the ultrasound head.
If the equipment decides that there is something wrong, USH may be displayed (see error codes page 23).

If the equipment detects a 'bad contact' situation, the intensity ,which was last measured, blinks on the intensity display. The output power is reduced and a control led, installed on the head, will light up.

As soon as The contact is sufficient, the intensity stops blinking and the microprocessor directs the AD converter (U15) in a way that it gives the same output voltage as there was before the bad contact situation, which should result in the same US power output as before. However, when the contact between the treatment head and the patient is not as good as before, there can be a slight difference.

In other words, when the power before bad contact was e.g. 1.7 W/cm², it is possible that in the end it results in an output power of 1.5 W/cm².

In case of insufficient contact the CONTACT output will be logic high, Q4 opens and a DC voltage is fed to the led in the ultrasound head. L5 and C89 filter out reverse HF noise, which may possibly disturb the μp.

13.4 Cable fraction detection.

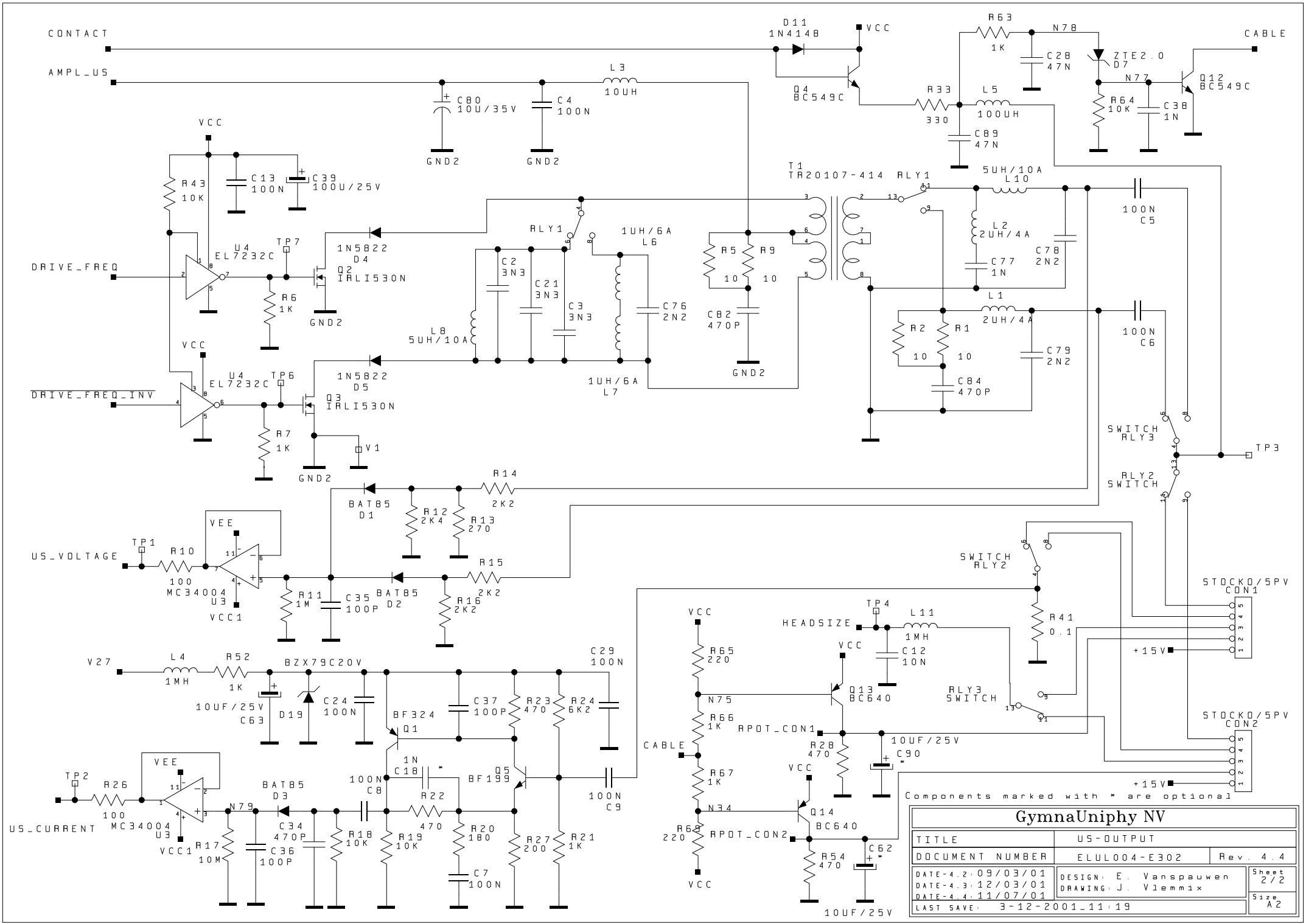
The Pulson 330 is provided with a detector, which constantly monitors the cable of the active US head.
In case of a cable fraction, the display shows Cab, and the treatment is ended.

(See output stage schematics)

When the contact of the US head is sufficient, the led on the head will extinguish.
The microprocessor now starts to give a short pulse on the led.
In fact, this pulse is short enough, so the human eye cannot see it.

Each time the pulse is sent, the voltage over this led is measured, and fed to Q12.
When the led lights up, the voltage at C28 is about 2.4 V.
To conduct, the voltage at the zener must be 2.7 V, so Q12 will stay closed.
If the cable is broken, the led will never light up, and the voltage at C28 becomes 5V.
This is enough for D7, so Q12 will conduct..
As a result, Q13 opens and the voltage on Rpot1* becomes 5 V.

(* When the active US head is connected on Con 2. If the active head is connected to Con 3, Rpot2 value is significant for the cable fraction detection).
Via U15 this data is read into the microprocessor.


CONTACT
AMPL_US
CABLE
D11
1N4148
VCC
Q4
BC549C
R63
1K
N78
C28
47N
ZTE2.0
D7
N77
Q12
BC549C
R64
10K
C38
1N
R33
330
L5
100UH
C89
47N
C80
10U/35V
C4
100N
L3
10UH
GND2
R43
10K
C13
100N
C39
100U/25V
T1
TR20107-414
RLY1
5UH/10A
L10
100N
C5
L2
2UH/4A
C77
1N
C78
2N2
L1
2UH/4A
C79
2N2
100N
C6
C84
470P
R2
R1
10
U4
EL7232C
TP7
DRIVE_FREQ
R6
1K
1N5822
D4
Q2
IRLI530N
C2
3N3
C21
3N3
C3
3N3
L8
5UH/10A
1UH/6A
L6
C76
2N2
R5
R9
C82
470P
1UH/6A
L7
DRIVE_FREQ_INV
TP6
1N5822
D5
Q3
IRLI530N
R7
1K
V1
SWITCH
RLY3
RLY2
SWITCH
TP3
R14
2K2
BAT85
D1
R12
2K4
R13
270
R15
2K2
BAT85
D2
R16
2K2
VEE
TP1
US_VOLTAGE
R10
100
MC34004
U3
VCC1
R11
1M
C35
100P
SWITCH
RLY2
R41
0.1
STOCKO/5PV
CON1
+15V
V27
L4
1MH
R52
1K
BZX79C20V
C29
100N
10UF/25V
C63
D19
C24
100N
BF324
Q1
C37
100P
R23
470
R24
6K2
TP4
HEADSIZE
L11
1MH
C12
10N
R65
220
N75
Q13
BC640
RLY3
SWITCH
R66
1K
RPOT_CON1
10UF/25V
C90
R28
470
CABLE
R67
1K
N34
Q14
BC640
R68
220
RPOT_CON2
R54
470
C62
10UF/25V
STOCKO/5PV
CON2
+15V
Components marked with * are optional
TP2
R26
100
MC34004
U3
VCC1
VEE
US_CURRENT
N79
BAT85
D3
C34
470P
R17
10M
C36
100P
R18
10K
100N
C8
1N
C18
*
R22
470
R19
10K
R20
180
C7
100N
BF199
Q5
R27
200
R21
1K
100N
C9
GymnaUniphy NV
TITLE
US-OUTPUT
DOCUMENT NUMBER
ELUL004-E302
Rev. 4.4
DATE-4.2: 09/03/01
DATE-4.3: 12/03/01
DATE-4.4: 11/07/01
DESIGN: E. Vanspauwen
DRAWING: J. Vlemmix
Sheet 2/2
Size A2
LAST SAVE: 3-12-2001_11:19

14. The display circuit.

The pulson 330 uses 7 segment L.E.D. displays. All display circuits are placed on a separate PCB, which is installed directly under the front panel.

14.1 Display circuits.

The display PCB is connected to the main board PCB via CON7.
All display data is coming via SDA and SCK which form the I^2C bus.

This I^2C bus is connected to multiplexers U1 and U2.
Since each multiplexer has only 16 outputs, which is insufficient to control all segments and leds, we use the two multiplexed outputs of U1 (MX1, MX2). Consequently, transistors Q4 and Q3 alternately switch, which makes it possible to control all segments and leds.

14.2 Display warnings.

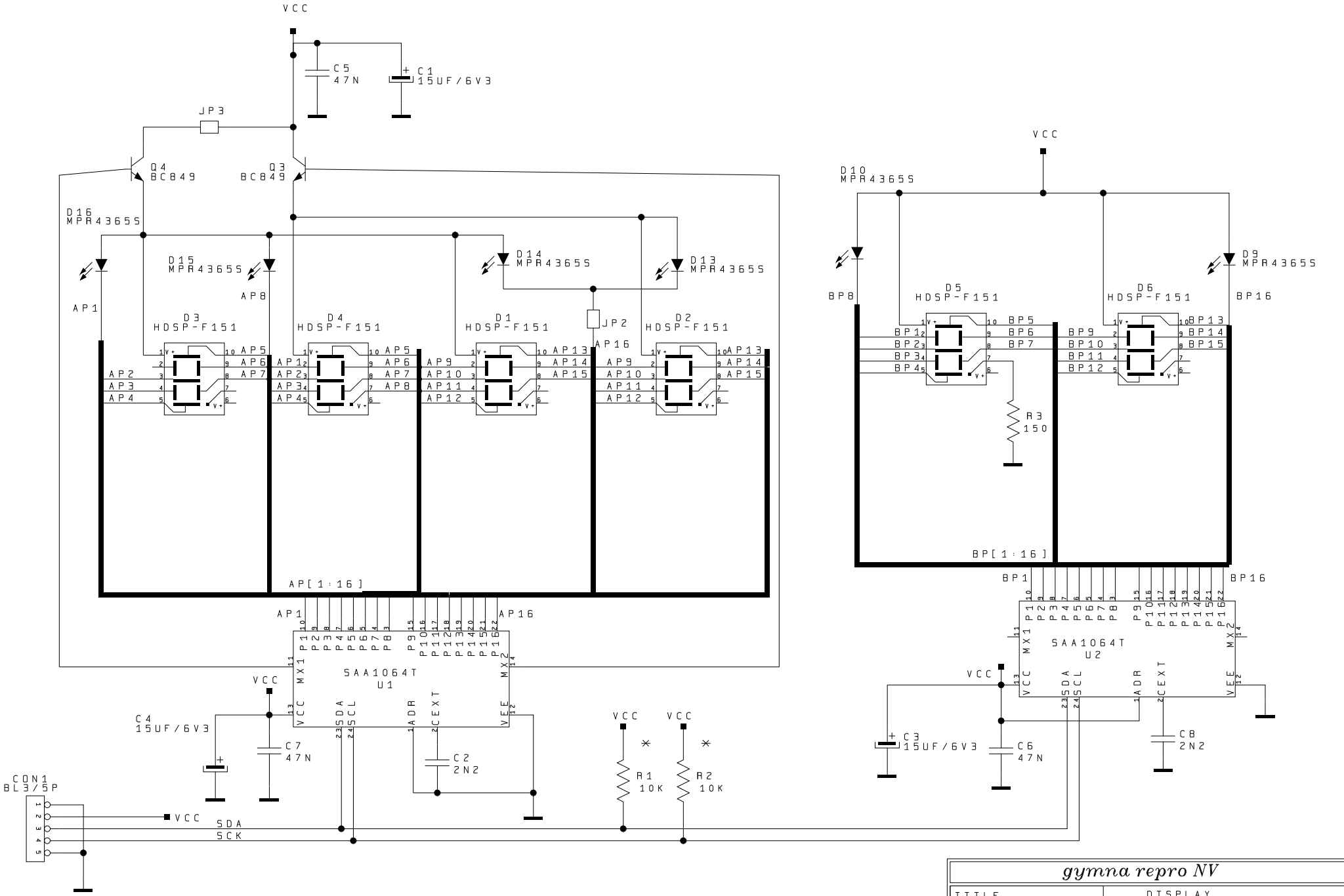
14.2 Display warnings

- USH: Connection between instrument and crystal is somewhere insufficient, or the crystal is damaged. (see error codes p 23).

- Flashing intensity value: The contact with the patient is insufficient. The output power is reduced and the contact control led on the head lights up.

- ‘•‘ : During initialising the display shows a point on the power display.
  The initialising normally should take about 2 sec.
  The same point appears during standby.

- CNT: When both timer keys are simultaneously pressed, the timer is switched off and
  the unit works continuously.



Components marked with * are optional

gymna repro NV		
TITLE	DISPLAY	
DOCUMENT NUMBER	ELUL004-E401	Rev. 2.0
DATE-1: 22/05/95 DATE-2: 24/08/95 DATE-3: xx/xx/xx	DESIGN: E. Vanspauwen DRAWING: E. Vanspauwen	Sheet 1/1
LAST SAVE: 12-7-1995_13:47		Size A2

15. Error codes.

The Pulson is built in a way that , during initialising, the most important sequences are tested before the instrument can be used. Under normal conditions, initialising takes about 2 sec., and is displayed by a single point on the intensity display. If no errors are detected, the initialising point disappears, and the instrument is ready to be used.
If an error is detected, it will be displayed.
The timer display shows ERR and the intensity display the error number.

- **ERR 1:** ROM check fail.
  The microprocessor detected a failure in its inside Eeprom.
  Solution: Changing the microprocessor.
  When a new microprocessor is installed, the upgrade routine has to be
  followed. (see page)

- **ERR 2:** Eeprom checksum fail.
  The checksum result of the microprocessor is different from the checksum
  result of the Eeprom.
  Solution: Change the Eeprom (IC U10).
  Since every Eeprom contains values specific for one output stage, the US
  output PCB and the Eeprom have to be returned to GYMNA for recalibration.

- **ERR 3:** Eeprom read
  Solution: same as ERROR 3.

- **ERR 4:** Eeprom write fail.
  Solution: Same as ERROR 3.

- **Cab:** Cable fracture detected.
  This error can also occur during treatment.
  The cable of the selected treatment head is broken, and need to be replaced.

- **USH:** In case of a USH warning, check following items:

  - Check all connections between the instrument and the ultrasound head.
    Open the head and check if all wires are connected.
    Also check for visual damage.

  - Open the corresponding USH head, take out the crystal and clean it.
    Close the head and try again.

  - If the problem doesn’t disappear, the crystal might be damaged.
    Change the crystal and its corresponding efficiency resistance (in the connector).

16. Measuring points.

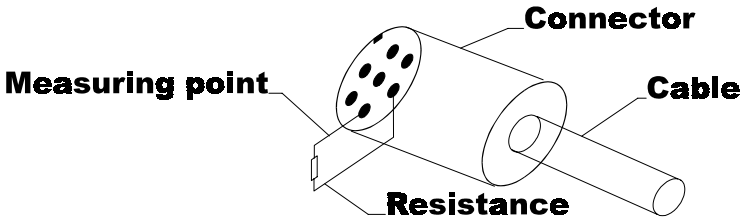
- Anode D22: 5 V stabilised.
- Kathode D21: - 5 V stabilised.

Following values can only be measured when the US - box is opened.

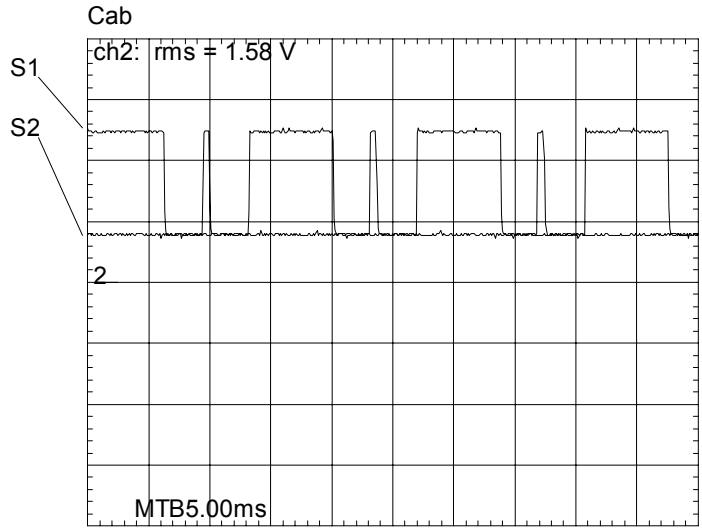
- L12: 32 VDC.
- Pin 1 CON 1/2: + 15 V stabilised.
- R35: + 15 V +/- 1%.
- Pin 14 of U15: + 5 V DC.

16.1 Cable fraction detection

Signal measured on efficiency resistance :



Ground is housing of the plug.



Switch the unit on without starting the treatment.
Connect the head which has produced the code Cab.
The signal S2 is a 1.5 VDC tension, which is displayed under normal functioning.
In case of a cable fraction, signal S1 appears.

17. Replacement procedures.

17.1 Bottom plate.

Removal: Switch off the unit and remove the mains cable from the mains entrance.
Put the unit upside down and remove the screws .
The bottom plate can now be removed by putting a small screwdriver under the bottom plate.

Installation: Same but in reverse order.

Caution: Do not forget to connect the earth cable between the unit and the bottom plate before closing the unit.

17.2 Main PC board (ELUL 004-L100-V20).

Removal: Disconnect the mains cable (CON 1 and CON 2).
Disconnect the flatcable from CON 10 (which connects the US board with the main board).
Disconnect the flatcable from CON 4 (connection with keyboard).
Remove all screws and take out the board.

Installation: Same but in reverse order.

Caution: Be sure you make the right connection between main board and the display print (black connector on the backside of the main board).

17.3 Ultrasound PC board (ELUL 004-L300-V30).

Removal: Disconnect the mains cable (CON 1 and CON 2).
Disconnect the flatcable from CON 10 (which connects the US board with the main board).
Disconnect the flatcable from CON 4 (connection with keyboard).
Remove all screws and take out the board.

Installation: Same but in reverse order.

Caution: Be sure you make the right connection between main board and the display print (black connector on the backside of the main board).

17.4 Display PCB (ELUL 004-L400-V20).

Removal: The ultrasound board is placed in a metal box to minimise magnetic radiation.
First remove screws between the US board and the main board. (at CON 10).
To open this unit , remove the three screws from the side panel on which this box is mounted. The box can be opened on the bottom side.
Desolder the bottom plate to open the unit.
Disconnect the output connectors (CON 1 and CON 2).
Unscrew CON 8 from the box and remove the screws from U1, Q2

and Q3.
You can now take out the US board.

Installation: Same but in reverse order.

17.5 Power transformer.

Removal: Disconnect connectors from CON 3, CON 6 and VLK 5 (earth cable).
Unscrew the bolt in the middle if the transformer.

Installation: Same but in reverse order.

Caution: Do not overtighten the self locking nut.

18. Repairing PC boards.

18.1 Which tools are necessary ?

- Be sure that you’ ve read the whole service manual, and thus that you know how all
  circuits function and which points are important.

- The following test equipment is required:

  - Ultrasound test bath.
  - Two beam oscilloscope
  - Multimeter
  - safety tester.
  - Professional soldering and desoldering equipment.
  - A complete set of precision engineering tools.

Make sure that all measuring equipment is calibrated.

- The unit has an Eeprom (U 10) which contains the calibration data of the output
  stage.
  Changing the output amplifiers or any Coils in the output circuit can not be
  done without the recalibration of the output stage.
  This calibration data has to be stored in the Eeprom, which can only be done by
  Gymna.
  The same goes for changing the Eeprom.
  Please send the US board together with the Eeprom to GYMNA.

18.2 Which procedure has to be followed?

- After repairing always follow the test procedure described in chapter.

- Always perform a safety test according to IEC 601-1
  See Chapter 3 technical data for limit values.

- Fill out the data registration document (page 5).

19. Storage and transport.

The Pulson 330 unit must always be stored and transported in its original package.
This package withstands normal shocks and vibration caused by transport.
The same conditions are required for accessories and spare parts.

20. Microprocessor versions and upgrades.

The Pulson 330 uses a One Time Programmable microprocessor.
The actual software version can be checked in following ways:

1. Push one keyboard key while switching on the instrument.
   The intensity display shows the software version, while the timer display shows the hardware jumper situation.

2. Open the unit . The software version is mentioned by means of a label on the microprocessor.

20.1 The upgrade routine.

During initialising, the microprocessor compares the checksum of its ROM with the value stored in the Eeprom. If there is a difference, an error code is produced.
An upgrade version always has a different checksum than the old version.
A software upgrade must be performed in following way:

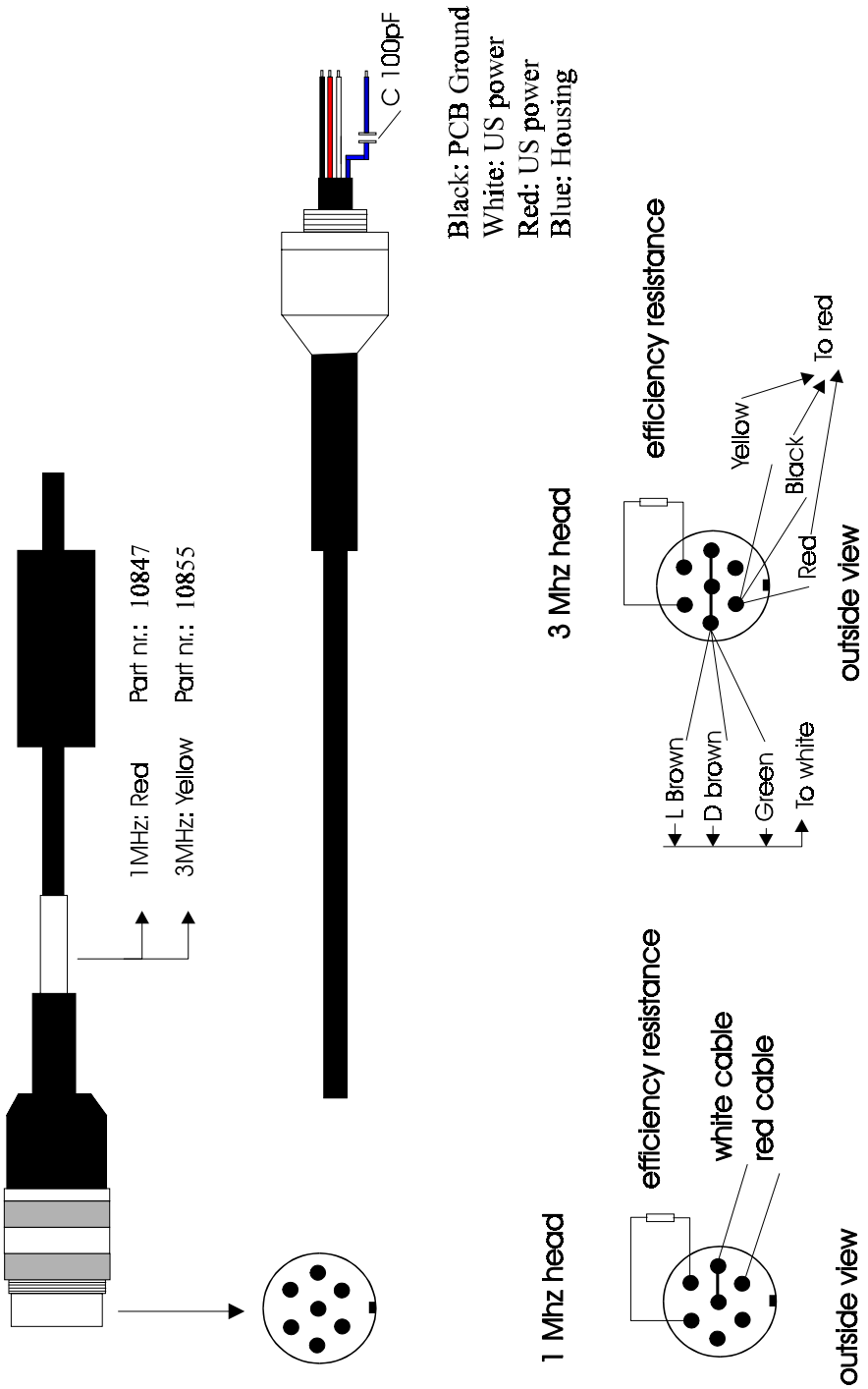
- Open the unit and take out the old microprocessor version.
- Put in the new microprocessor and put a jumper on CON1 (Main board).
- Switch on the unit.
- Upgrading is done when the '----' symbols disappear and the new software version is displayed.
- Switch off the unit, remove the jumper and close the unit.

20.2 Microprocessor software versions.

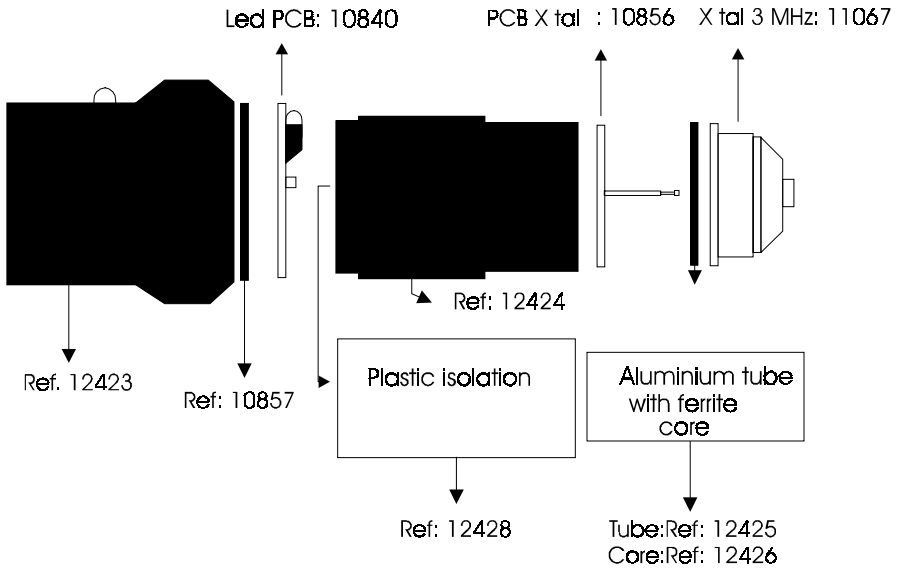
First date of issue: 13/03/1996
Software version: 5.1
Hardware Jumpers: none
Remarks: This is the first software version, installed in all units starting from serial number 1.

First date of issue: 15/03/1996
Software version: 5.3
Hardware Jumpers: none
Remarks: Installed in all units starting from serial number 45.
Because only small software inconveniences have been eliminated, a software upgrade is not necessary.

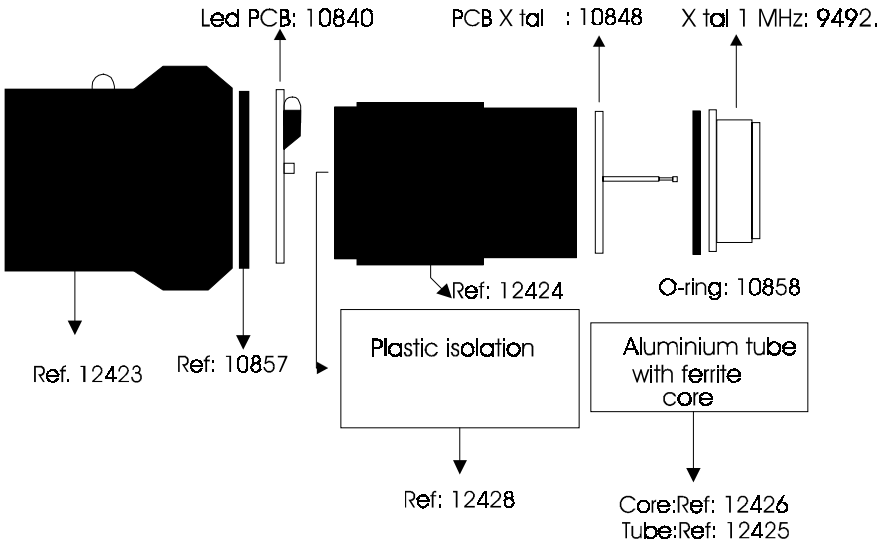
21. The ultrasound heads.



3 MHz Head



1 MHz Head



22. Returning defective parts.

22.1 Guarantee claims.

To return parts from guarantee claims, they must **FIRST** have an approval from GYMNA.
The claim can be presented by means of an ‘ REQUEST RETURN DEFECTIVE PARTS’ form.
This approval (RAN = Return Authorisation Number) is requested at GYMNA- HQ for each part which you like to send back.
Each defective part must be tagged with a ‘ PARTS RETURN TAG’, which is filled in correctly, including the RAN number.

22.2 Defective parts.

To return defective parts , they must **FIRST** have an approval from GYMNA.
The defective part can be presented by means of an ‘ REQUEST RETURN DEFECTIVE PARTS’ form.
This approval (RAN = Return Authorisation Number) is requested at GYMNA- HQ for each part which you like to send back.
Each defective part must be tagged with a ‘ PARTS RETURN TAG’, which is filled in correctly, including the RAN number.

22.3 Filling out the ‘Request Return Defective Parts’ form.

- Clearly and completely fill in the ‘ REQUEST RETURN DEFECTIVE PARTS ‘ form.
  (see page for an example)

- Send this form by fax to following address:
  GYMNA SERVICE DEPARTMENT.
  BILZEN, BELGIUM
  FAX NO: ++32/510.561

- Within two working days you will receive the form back by fax.
  You can see that the RAN number has been filled in.
  Fill out the number and the rest of the data on the ‘ PARTS RETURN TAG’ and tag the
  defective part. All accepted parts can now be send to the GYMNA service department.

Request Return Defective Parts

Service

from *GYMNA-UNIPHY SERVICE DEPARTMENT*
Tel: +32 (0)89 510.560
Fax: +32 (0)89 510.561

PART TO BE COMPLETED BY THE CUSTOMER

1. COMPANY NAME AND ADDRESS Treated by: DNV

- **Fax Number:**
- **Your Reference:**
- **Date:**

2. ARTICLE INFORMATION

- **Article Name:**
- **Part Number:**
- **Serial Number:**

3. WHAT IS THE REASON FOR RETURNING THE INSTRUMENT OR PART?

4. Return: ☐ Repair: ☐
5. Warranty: YES ☐ NO: ☐
6. Return with next shipment ☐ Return asap ☐

PARTS RETURN TAG

gymna **PARTS RETURN TAG** | **RAN**

Date:

INSTRUMENT INFO:	DEFECTIVE PART INFO:
NAME:	NAME:.....
SER. NUMBER:	SER. NUMBER: .....
	PART NUMBER:.....

Problem:

.....

.....

.....

.....

Important note: properly attach this tag to the defective part. Part will not be accepted without RAN Number

24. Spare parts.

All spare parts used in the pulson 330 unit are listed in following pages.
It gives a separate list for each PCB as well as for the accessories.

We marked the spare parts from which we think there are important to keep in stock with an I
(second column).

23.1 Ordering.

To order spare parts, following data must be provided:

- Part number
- Description
- Quantity

Under normal conditions, spare parts are delivered within ten working days after ordering.
If spare parts cannot be delivered within these ten days, the GYMNA spare parts
department will get in contact to give an estimated delivering period.

Spare parts list for 1/3 MHz ultrasound heads

PCB Article	Description	Imp	Ordering number
11067	X-tal 3 MHz (with resistance)		
	X-tal 1MHz (with resistance)		09492
	PCB for X-tal 3 MHz		10856
	PCB for X-tal 1 MHz		10848
	Upper housing Aluminium (1/3 Mhz)		12424
	Under housing aluminium (1/3 Mhz)		12423
	Rubber O-ring (36 x 3 mm)(1/3 Mhz)		10857
	Aluminium tube(inside) (1/3 Mhz)		12425
	Rincore black (1/3 MHz)	12426	
	LED pcb complete (1/3 MHz)		10840
10858	Rubber O-ring (1/3 MHz) (33 x2.62 mm)		
12428	Plastic insulation plate(inside)	(1/3 MHz)	

Spare parts list for PCB: ELUL 004 - L100 - V20

PCB Article	Description	Imp	Ordering number
1. PCB complete		10555	
PCB complete ELUL 004-L100-V20			
2. Capacitors			
C1,3,24,26	100nF/100V SS		3589
C2,65,66,67,68	100uF/25 V		7431
C16	10000uF/ 10 V		9057
C21	2200uF/ 35 V		8004
C23	100uF / 35 V		7426
C40, 41	1uF / 50 V QS		3580
C44, 46	33 pF / DS		8000
C53, 54, 55, 56, 57	47 nF SS		8001
C59, 60	1 uF/ 50 V DS		3587
C64	22 uF/ 6.3 V		8556
C81	8 x 470 pF SIL network		5522
3. Diodes			
D1 to D14, D23 to 46	1N4148		3600
D18	led L-9341 ID -B red round 3 mm		3614
D21,22	1N4007		3594
D47, 48	KBPC 602 bridge		3592
4. Resistors			
R1,2, 6 to 9, 25, 66, 67	10K MRS25		3679
R3	10K SIL network	3671	
R4	8 x 2K2 SIL network		8011
R44	100 K MRS25	3680	
R60, 62	4K7 MRS25		6067
R63	330 R MRS25	8091	
5. Transistors			
Q1, 9	BST70A FET	7573	
Q11	BC549C NPN	3702	
6. Crystal			
Y3	12 Mhz		8046
7. Relays			
RLY 4	MZ5HS		
8. Integrated circuits			
U1	Z86E21		
U2	MAX 1232		
U6	74HC4538	3642	
U10	X24C16		7440

PCB Article	Description	Imp	Ordering number
U12	L4940		8136
U13	79L05		3663
9. Buzzer			
BZ1	SV4/5		3696
10. Connectors			
CON1	Stripcontact 2p		8430
CON3	Stocko header 4p		8085
CON4	stripcontact 8p		8435
CON5, 6	modu I10p straight print		9726
CON7	BL11-5		
CON10	3M-16PDR		
VLK1 to 4	PCB blade 4.8 x 0.8		3550
JP1	header 50p		3549

Spare parts list for PCB: ELUL 004 - L300 - V20

PCB Article	Description	Imp	Ordering number
1. PCB complete			**10558**
PCB complete ELUL 004-L300-V20			
2. Capacitors			
C1,10	47 pF/ 100 V DS		3585
C2, 3, 21	3n3 F / 100 V DS		10258
C4, 5, 6, 7, 8, 9			
C11, 13, 15, 16,			
C45, 48, 49, 69, 74	1 nF/ 100V SS		3589
C12	10 nF/ 63 V DS		3574
C14, 27 to 33, 58, 89	47 nF SS		8001
C17, 19, 20	220 pF / 100 V SS		3590
C18	1 nF / 100 V DS		9353
C22, 35, 36, 37	100 pF/ band DS		8006
C39	100 uF/ 25 V		7431
C42	10 uF / 16V		6108
C43	1000 uF/ 35 V		3571
C50, 51, 85 to 88	33 pF DS		8000
C62, 63, 90	10 uF / 50V		8002
C76 to 79	2n2 / 100 V		9355
C80	10 uF / 35 V tantalum		8083
C82, 84	470 pF/ 100 V DS		0334
2. Resistors			
R1,2	10R / 2W		10240
R3, 8, 18, 19, 29,			
R30, 34, 39, 42 to 50,			
R53, 62, 68	4K7 MRS25		6067
R4	13 K / 4W		
R5, 9	10 R pro3		8093
R6, 7, 21, 52	1K MRS 25		3681
R10, 26	100 R MRS 25		6141
R11	1M MRS 25		3689
R12	2K4 MRS 25		7455
R13	270 R MRS 25		9116
R14, 15, 16	2K2 MRS 25		3678
R17, 55	10M MRS 25		3690
R20	180 R MRS 25		3687
R22, 23, 28, 54	470 R MRS 25		3692
R24	6K2 MRS 25		8565
R25, 40, 58	8K2 MRS 25		3688
R27	200 R MRS 25		8945
R31	100 K MRS 25		3680
R32	910 R MRS 25		8948
R33, 56, 57	330 R MRS 25		8091
R35	16 K MRS 25		6068
R36	560 K MRS 25		9357
R37	130 R MRS 25		8949
R38	1K6 MRS 25		8946

PCB Article	Description	Imp	Ordering number
R51	56 K/ 4W		
R59	30 K MRS 25		7458
R60	39 K MRS 25		8024
R61	5K6 / 4W		
3. Diodes			
D1, 2, 3	BAT 85 PH		9239
D4, 5, 6	1N 5822 schotky		8084
D11, 12, 13, 14	1N4148		3600
D15	LM 336 5.0		10077
D16, 17	L - 934 ID- B led round 3mm		3614
D19	B-79C20V		
D20	1N4007		
4. Inductors			
L1, 2	2 uH/ 4A		10073
L3	10 uH / 3 A		8129
L4, 11	1 mH		8938
L5	100 uH / 85 mA		8127
L6, 7	1 uH / 6 A		10074
L8, 10	5 uH / 10 A		10075
L9	220 uH/ 1 A		8126
L12	3 uH / 2A		8130
T1	TRV 1/3 Mhz		10076
5. Transistors			
Q1	BF 324 PNP		8982
Q2, 3	BUK 543 100A		8088
Q4, 6, 7, 8, 9	BC 549 C NPN		3702
Q5	BF 199 NPN		8981
Q10	BST 70 A FET		7573
Q11	BC 640 PNP		3705
6. Relais			
RLY 1, 2, 3	HLX 200 B00 5V / 2c		6118
7. Crystal			
Y1	6 Mhz		3668
8. Integrated circuits			
U1	MC 33166T		8095
U2	LM 78L15		
U3	MC 34004		
U4	EL 7232 CN		9705
U5	74 HCT 04		7613
U7	74 LS92A		10242
U8	74 HCT 153		8094
U15	PCF 8591		9703

9. Connectors

CON 1, 2	stocko header 5P	8007	
CON 8	SUBD 15 p male	9728	
TP1, 2, 3, 4, 6, 7, 8	header 50p x 5.54 x 12		3549

Spare parts list for PCB: ELUL 004 - L400 - V20

PCB Article	Description	Imp	Ordering number
1. PCB complete			**10578**
PCB complete ELUL 004-L400-V20			
2. Capacitors			
C1, 3, 4	15 uF / 6.3 V SMD		
C2, 8	2n2 F SMD		
C5, 6, 7	47 nF SMD		
3. Diodes			
D1 to 6	7 seg display HDSP- F151 red		6046
D9, 10, 13 to 16	led MPR 4365S red round		8547
4. Transistors			
Q3, 4	BC 849 C SMD		9169
5. Resistors			
R1, 2	10K SMD		
R3	150 R SMD		
6. Integrated circuits			
U1, 2	SAA 1046		10079
7. Jumpers			
JP 2, 3	Jumper SMD		
8. Connectors			
CON 1	BL3-5		